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Assessing juicy elements in interactive infographics

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ABSTRACT

Introduction: Juiciness refers to the use of various audiovisual effects that are triggered in response to user interactions. This study explores the presence of juicy elements in interactive infographics, thereby extending the investigation of juiciness beyond traditional gaming contexts. **Methodology:** A descriptive research approach, employing content analysis, was used to evaluate a sample of interactive infographics published between 2010 and 2024. The sample was collected from four prominent sources, and each visualization was analyzed using a binary classification system (YES or NO) to indicate the presence of the identified juiciness elements: animation, particles, audio feedback, screen shake, and persistence. **Results:** Overall, the findings indicate that juicy elements are present in certain interactive visualizations, though not universally across all examples. The data revealed that animation appeared most frequently, with an occurrence rate of 73.85%, followed by particles (20.51%), audio feedback (5.64%), persistence (4.1%), and screen shake (1.03%). Furthermore, 25.64% of the visualizations contained no juicy elements. **Discussion:** The findings from the analysis reveal that juicy elements are present in a significant number of interactive visualizations, but none of the visualizations analyzed incorporated all five juicy elements simultaneously. Despite the presence of some juicy elements, no single visualization captured the full essence of juicy design, which ideally offers a high level of feedback from minimal user input. **Conclusions:** While no single visualization incorporated all five juicy elements, combinations of up to four were observed, suggesting that juiciness does not require a uniform or exhaustive application of all elements.

Keywords: infographics; data visualization; interactive; engaging design.

RESUMEN

Introducción: Esta investigación examina el nivel de cumplimiento con los estándares de calidad y transparencia en revistas académicas de acceso abierto diamante publicadas por la Universidad Autónoma de Nuevo León (UANL). El estudio se centra en la evaluación de la implementación de prácticas que optimizan la visibilidad, accesibilidad y reutilización del contenido académico. **Metodología:** Se realizó un análisis documental del contenido presente en las plataformas web de 38 revistas institucionales. La evaluación se basó en los principios de transparencia y buenas prácticas establecidos por organizaciones de referencia internacional, incluyendo el *Committee on Publication Ethics* (COPE), el *Directory of Open Access Journals* (DOAJ), la *Open Access Scholarly Publishing Association* (OASPA) y la *World Association of Medical Editors* (WAME). Para la evaluación, se utilizó un instrumento diseñado en la herramienta QuestionPro, que permitió calificar los indicadores seleccionados. **Conclusiones:** Los resultados revelan una significativa heterogeneidad en el cumplimiento de los estándares evaluados entre las diferentes publicaciones institucionales. Esta disparidad en la adhesión a las prácticas recomendadas sugiere la existencia de brechas sustanciales en la implementación de políticas editoriales fundamentales. La variabilidad observada en los resultados representa tanto un desafío institucional como una oportunidad estratégica para el desarrollo. La identificación de prácticas exitosas dentro del propio ecosistema universitario proporciona una base sólida para impulsar el desarrollo institucional. Estos hallazgos constituyen una oportunidad crítica para consolidar la posición de la UANL en el ámbito de las publicaciones de acceso abierto.

Palabras clave: infografía; visualización de datos; interactividad; diseño atractivo.

1. INTRODUCTION

In digital games, a technique that has long been used to promote engagement is making them "juicy." Juiciness refers to the use of multiple audiovisual effects (e.g., animations, particles, persistence, sound effects) that are triggered as feedback in response to a player's inputs (Walz & Deterting, 2014; Schell, 2008; Johansen et al., 2021). Previous research on juiciness has primarily focused on its application in games (Hicks, 2020; Kao, 2020; Durmanova, 2022). Some of these studies suggest and recommend exploring this concept in non-gaming environments (Hicks, 2020; Durmanova, 2022), pointing out "there is a strong motivation for exploring the potential for juiciness to be used outside this gaming context and applied to more general interaction design" (Hicks, 2020). On the same direction, Singhal and Schneider (2021, p. 2) believe that Juiciness "is also a useful concept for designing feedback in other interactive media such as animations or movies". Among such environments, interactive infographics are a promising medium where the potential of juiciness could be further investigated and explored.

Over the years, infographics have gained widespread acceptance, offering readers a way to access complex content by combining visual representation techniques with design elements that help convey intricate information (Smiciklas, 2012; Cairo, 2013; Krum, 2013). Infographics have also evolved, becoming increasingly dynamic and

interactive. This evolution mirrors the growing trend of user engagement with interactive content, from digital games to smartphone applications and wearable technologies (e.g., smartwatches).

This research aims to investigate the presence of juicy elements in interactive infographics and data visualizations that are freely accessible online. We believe our research will contribute to both academic and industry contexts.

Academically, this study may bridge the gap in the exploration of juiciness in non-game design projects (e.g., mobile apps, websites, digital publications), as it is the first to examine its application outside gaming environments. For the industry, our findings could be valuable to interactive and graphic designers seeking to incorporate juiciness deliberately and meaningfully in the development of interactive infographics and data visualizations. Juiciness also presents a relatively low-cost way to enhance user engagement in existing interactive applications.

It is hypothesized that juiciness can enhance engagement in infographics. To examine this potential, the first step proposed in this research is to assess whether current infographics incorporate juiciness elements and to what extent. The following research question is posed to guide this investigation:

RQ: Which, and how many, of the following juicy elements —animation, particles, audio feedback, screen shake, and persistence— are present individually or in combination in existing online interactive visualizations?

The paper begins with a review of the literature on the concepts of Juiciness, Juicy Elements, and Interactive Infographics, followed by a description of the Methods employed. This is followed by a presentation of the Results and a Discussion of the findings, with attention to Limitations and Suggestions for Future Research. The paper concludes with the Conclusion and References.

2. Juiciness

The interaction between users and systems usually involves back-and-forth actions: the user makes an input action, that is then received by the system which will interpret it, and return an information to the user, ideally based on the input previously made. This returned information is called Feedback and might affect what the user might be able to do next (Schell, 2008). The amount –and maybe quality– of feedback provided to the user might affect the experience they will have with a system. In games, if too little feedback is provided, an interface might be described as "dry". Juicy systems, on the other hand, will provide the player with a lot of feedback that feels very rewarding. On a talk titled "Juice It or Lose It", Martin Johansen and Petri Purho (2003) provide some basic examples on how a game can be converted from "dry" to "juicy", by sampling adding some effects such as particles, screen shakes, explosions, bass tone sounds and others.

Overall, research about Juiciness, mostly related to the context of game design, supports it has positive aspects whenever applied. Schell (2008, p. 233) proposes "The Lens of Juiciness", where juicy interfaces will provide the player with lots of powerful,

interesting, and continuous feedback in form of rewards. The author states that, to promote a fun and positive experience to the player, the juicier, the better. Kucic (2005) states that juicy games feel alive, with elements that bounce, wiggle and squirt, making little noises, responding to every minimal player action.

When examining different levels of juiciness, aiming to convey "juicy design" as a term to be used in academic contexts, Atanasov (2013) concluded that "the quality of Juiciness defines conditions that foster a positive emotional response, a feeling of reward and satisfaction and an overall enjoyment of being within the game world.", demonstrating that Juiciness can positively affect player experiences with games.

Still, some research also suggests that Juiciness should be carefully thought out before their implementations (Hicks, 2020). If minimal or extreme, Juiciness can have negative impacts on player experience (Kao, 2020).

These quotes pose an important aspect to be considered when designing a juicy experience, even more so if the target audience is not primarily made of video game players.

2.1. Juicy elements

To achieve a "juicy" experience, game designers incorporate various elements and techniques into their projects. According to Kucic (2005) "A juicy game element will bounce and wiggle and squirt and make a little noise when you touch it." These elements may be applied individually or in combination to enhance the sense of juiciness experienced by users when interacting with an interactive visualization or game. Building on prior research and identified occurrences (Hicks, 2020; Kao, 2020; Durmanova, 2022), the following Juicy Elements were selected for investigation:

Animation: Animation refers to dynamic or moving elements within a layout, utilizing frame transitions to create the illusion of motion from a sequence of static images. In the context of juiciness, animation is applied to a variety of objects within a scene, employing diverse movement types, including rotations, size variations, multi-axis movement, and distortions, among others.

Particles: Particles are elements or objects that respond to events within a scene. They consist of small units —often single pixels or groups— that appear before, during, or after events such as collisions, friction, or explosions. Particles are animated and behave according to specific system settings, including physics, quantity, and speed. In interactive infographics, particles may represent data values or quantities, as seen in Histography (Stauber, n.d.), where tiny, animated dots behave like particles in response to user inputs

Audio Feedback: Audio feedback includes sounds played during the interactive experience, encompassing both music and sound effects that respond to events, such as a "crash" sound upon object collision. An example is Listen to Wikipedia by Stephen LaPorte and Mahmoud Hashemi (2015), which uses sound effects to signify recent Wikipedia edits. Here, "bells indicate additions, and string plucks indicate subtractions,

with pitch variations based on edit size; larger edits produce deeper notes" (LaPorte & Hashemi, 2015).

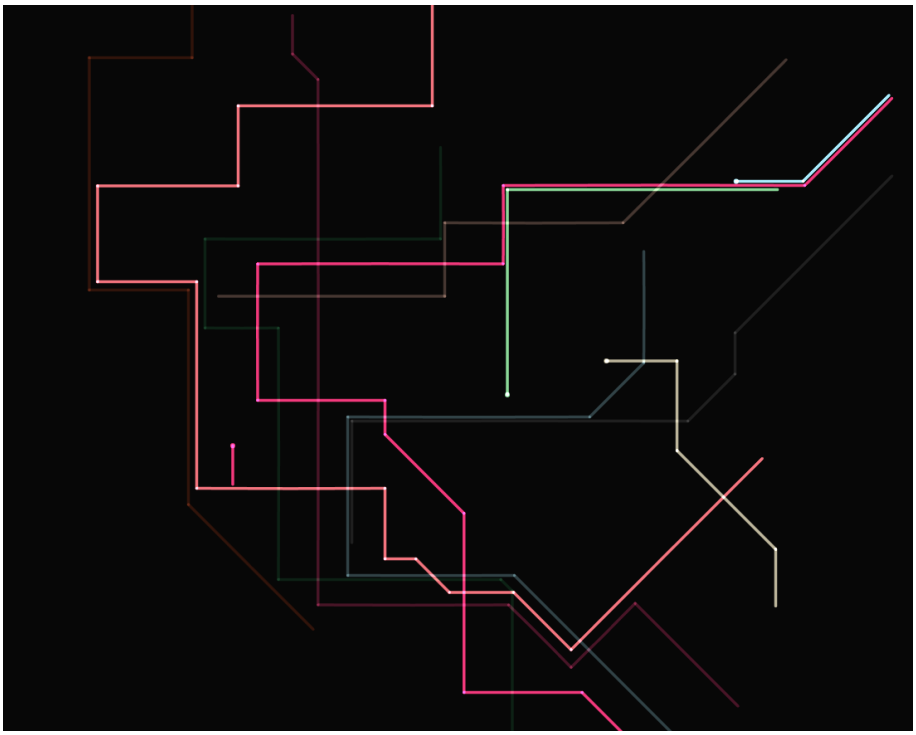
Screen Shake: Screen shake is an effect involving the movement of the entire screen and its visual elements, serving as an additional layer of user feedback in response to events such as collisions, explosions, or sounds. This technique is explored in Optikamer (Team Optikamer, 2016), where subtle screen shakes occur when the user-controlled object jumps or lands.

Persistence: Persistence refers to visual traces left by events that occur during interaction. These traces can be either permanent or temporary, and include both instant effects, such as footprints, and lasting changes, like a wall crack resulting from user input. An example of persistence can be observed in the interactive infographic Construct (Figure 1), which "transforms the New York subway system into an interactive string instrument" (Chen, 2011). Here, the lines representing subway paths remain visible temporarily, gradually fading out.

The exploration of juiciness highlights its potential to enhance user interaction by adding dynamic and engaging elements to digital experiences. While many of the juicy elements identified are commonly associated with games, their application in other interactive formats, such as infographics, also offers significant opportunities. As we shift focus to interactive infographics, it is important to consider how these elements might be integrated into visualizations designed to communicate complex information, enhancing both the engagement and the clarity of the message being conveyed.

Figure 1

The Juicy Element of Persistence: the lines persist for a while before disappearing.



Source: Construct at mta.me (Chen, 2021).

3. Interactive infographics

Infographics have long been an essential tool for distilling complex data into a format that is visually accessible and engaging. By transforming dense information into visual representations such as charts, maps, and diagrams, infographics facilitate faster comprehension and easier interpretation of data. Cairo (2013) explains that infographics tell stories through these visual elements, enabling the communication of messages more effectively. Smiciklas (2012) similarly defines infographics to visualize data or ideas to convey complex information in a way that is quick to consume and easily understood, which makes them highly valuable in a variety of contexts. Traditional static infographics have been widely used in print and digital media, offering a straightforward and impactful way to present data in a visually compelling format. However, with advancements in digital technology, a new form of infographics has emerged: interactive infographics. These take the concept of static infographics a step further by integrating interactive elements that allow users to actively engage with the content. According to Krum (2013), interactive infographics combine data visualization with user interactivity, enabling individuals to manipulate the content directly— whether through clickable elements, sliders, buttons, or other tools— offering a more immersive and personalized experience.

This interactive aspect not only engages users but also encourages them to explore data in a non-linear fashion, providing deeper insights based on their own interactions. Users can zoom into specific data points, filter content according to different criteria, or even alter variables and observe how the data changes in real-time. Zwinger & Zeiller (2016) argue that such interactive elements enable a dynamic exchange between the content and the user, where the experience adapts according to user input, allowing for a richer understanding of the information presented.

The inclusion of interactivity in infographics has been shown to have several advantages over static formats. For one, interactive infographics tend to generate greater user engagement. Burnett et al. (2019) observe that the introduction of interactive features in infographics often leads to increased user motivation, as individuals are more likely to invest time in exploring content that they can manipulate and control. This type of active engagement enhances the likelihood of information retention, as users can experiment with data, test hypotheses, and navigate through complex sets of information in a way that is personalized to their interests and needs. Furthermore, interactivity provides a level of interactivity where users actively contribute to the construction of meaning, making the information not only easier to understand but more memorable.

Interactive infographics also tend to be more attractive than static ones. According to Tarkhova et al. (2020), the ability to interact with data and visually manipulate elements in real-time makes these infographics visually appealing and encourages users to spend more time exploring the content. When data or information is represented dynamically, it not only draws users in but also allows for a more fluid and engaging interaction with the material. This immersive experience becomes a powerful tool for engaging users in educational and professional settings. For example, in educational contexts, interactive infographics can help enhance learning by providing

a multimedia approach that appeals to various learning styles. By integrating visuals, text, and interactive features, these infographics can cater to both visual and kinesthetic learners, thereby improving information absorption and retention (Ismaeel & Mulhim, 2020).

The interactive design of these infographics allows users to immerse themselves in the content, providing them with a more flexible way of interacting with and interpreting information. Unlike static infographics, which are typically passive, interactive infographics offer users the ability to explore data through real-time actions. Such interactions —such as dragging, hovering, or scrolling— empower users to navigate content in a more engaging and personalized manner. As a result, interactive infographics not only hold the potential for increased user engagement but also enhance the attractiveness and memorability of the information being presented.

Given their growing prevalence across multiple fields —ranging from journalism and business to education and healthcare— interactive infographics have proven to be effective in enhancing the user experience. However, despite their increasing popularity, the design and implementation of juicy elements—such as animation, particles, and audio feedback—are still underexplored within the context of interactive infographics. Therefore, the next section of this research delves into the use of these juicy design elements within interactive infographics. By analyzing a variety of interactive visualizations, this study aims to determine the extent to which juiciness is incorporated and assess its potential impact on user engagement and the overall effectiveness of these digital visualizations.

4. METHODOLGY

For this research, a list of interactive infographics and data visualizations was examined. The collection process began with Google searches using prompts such as "best interactive infographics," "top interactive infographics," "best interactive data visualizations," "top interactive data visualizations," "best interactive data viz," and "top interactive data viz." Specific years were appended to these search terms to expand the date range. Despite using various search terms, considerable overlap was observed, leading to several websites that curated what their staff considered the best examples of interactive infographics and data visualizations. Among these, four sources were the most significant and comprehensive based on the quantity of links provided: "101 Visually Stunning Interactive Infographics to Inspire You" compiled by Katy French (2021) from Column Five Media; "The 100 Best Infographics [Interactive]" curated by Ross Hudgens (2021) from Siege Media; the Information is Beautiful Awards website; and annual "best-of-the-year" lists from the Flowing Data website.

The lists from Siege Media and Flowing Data included both interactive and non-interactive infographics, so only those categorized as interactive were considered. For the Information is Beautiful Awards website, results were filtered using the "interactives" tag, yielding 12 pages of interactive visualizations. Although the exact number of projects could not be determined due to randomized content refreshes, an estimated 200+ projects were identified. Across these primary sources, repeated visualizations were also mapped. Additionally, a few other examples were gathered

from various online sources, including developers' and companies' websites featuring interactive visualizations.

A total of 195 accessible and functional links remained after reviewing each individual entry. While the initial list was expected to be larger, numerous broken links and unavailable visualizations reduced the count. Certain technologies used to create older infographics —such as Adobe Flash— are no longer supported by modern browsers, and some domains are no longer maintained.

The criteria for including an infographic in the final list were as follows: each infographic had to be accessible online at no cost (i.e., without paid subscriptions or donations), and it had to be categorized by either the list organizer or creator as an interactive infographic, interactive data visualization, or interactive visualization (such as interactive maps). Visualizations with incomplete access, such as missing images, static samples, or video demonstrations, were excluded.

The final set of visualizations was then cataloged in a spreadsheet recording the following information for each entry: title, author(s), publication year, and the presence of five types of juicy elements—animation, particles, audio feedback, screen shake, and persistence. The publication date was included to allow for trend observation over time regarding juiciness in interactive visualizations. In cases where the publication date was not immediately available, the Wayback Machine was utilized to approximate the original publication period.

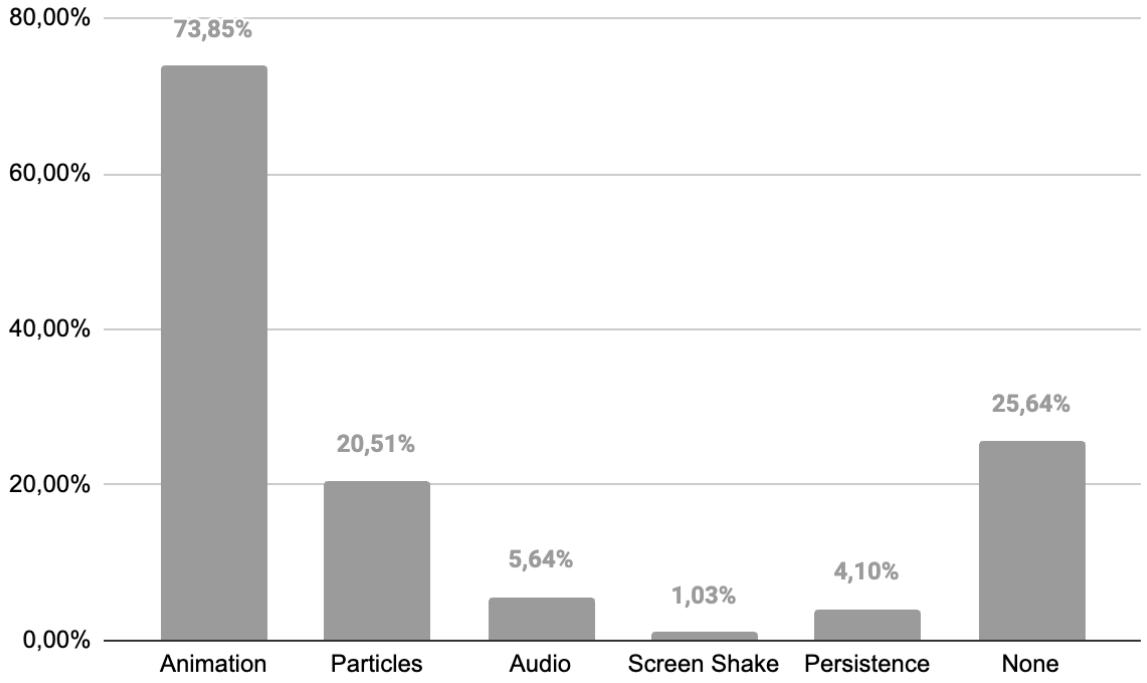
Each link was revisited to assess the presence of juicy elements, which were classified using a binary (YES or NO) system without quantifying intensity or frequency. Interaction with available interactive elements such as buttons, sliders, links, draggers, hover effects, and input fields was conducted using mouse or keyboard inputs. Notably, while all interactions took place on a computer, it is acknowledged that some visualizations may also be compatible with mobile devices. The findings are presented in the following section.

5. RESULTS

Overall, the findings indicate that juicy elements are present in certain interactive visualizations, though not universally across all examples. Figure 2 illustrates the percentage distribution for each element.

Figure 2.

Overview of Juicy Elements on Interactive Infographics



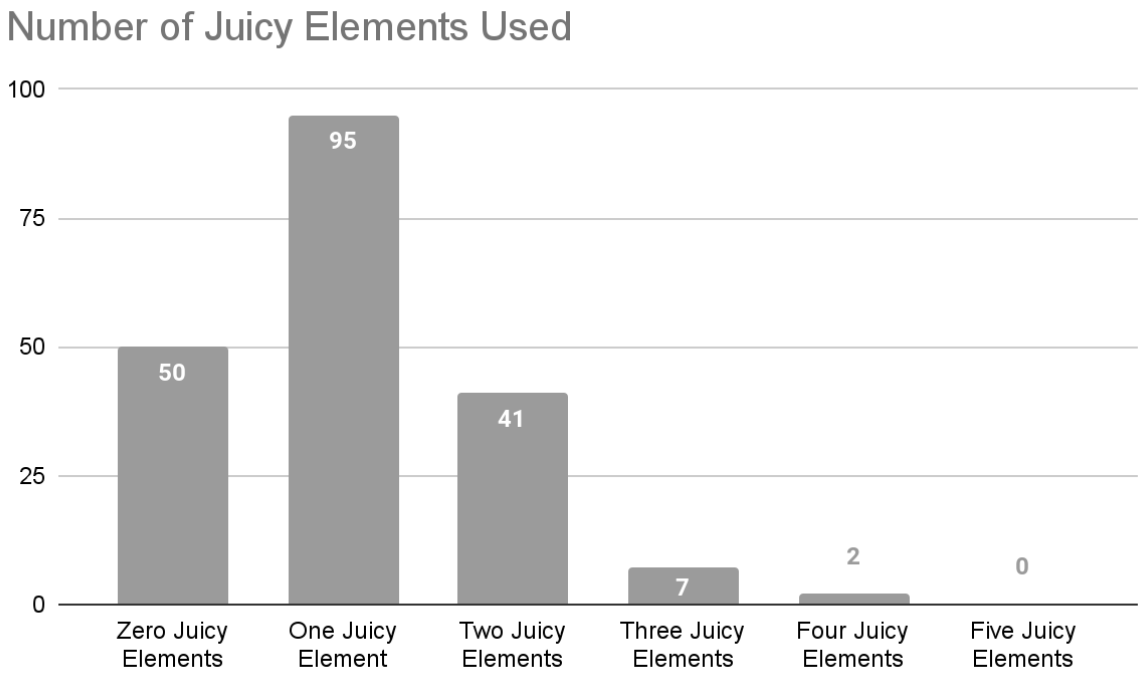
Source: Own elaboration, 2024.

All juicy elements were identified across multiple instances within the analyzed visualizations. The data presented in the graphic indicate that animation appeared most frequently, with an occurrence rate of 73.85%, followed by particles (20.51%), audio feedback (5.64%), persistence (4.1%), and screen shake (1.03%). Furthermore, 25.64% of the visualizations contained no juicy elements.

It is believed that it is important to verify the amount and types of juicy elements used together along different samples. By performing that analysis, it is possible to identify the dominance of a single element and what elements are most used in combinations in different occurrences. For that analysis, visualizations were categorized based on the number of juicy elements each contained, as depicted in Figure 3. Additionally, efforts were made to determine which elements were commonly used together and the frequency of these combinations, as outlined in Table 1.

Figure 3.

Number of Juicy Elements Used Together.



Source: Own elaboration, 2024.

Table 1.

Combination of Juicy Elements

0 Juicy Elements	**50**
1 Juicy Element Only	**95**
Animation	94
Particles	0
Audio	1
Screen Shake	0
Persistence	0
2 Juicy Elements Only	**41**
Animation + Particles	34
Animation + Audio Feedback	4
Animation + Screen Shake	1
Animation + Persistence	2
3 Juicy Elements Only	**7**
Animation + Particles + Audio Feedback	2
Animation + Particles + Persistence	3

Animation + Audio Feedback + Persistence	2
4 Juicy Elements Only	**2**
Animation + Particles + Audio Feedback + Screen Shake	1
Animation + Particles + Audio Feedback + Persistence	1
5 Juicy Elements	**0**

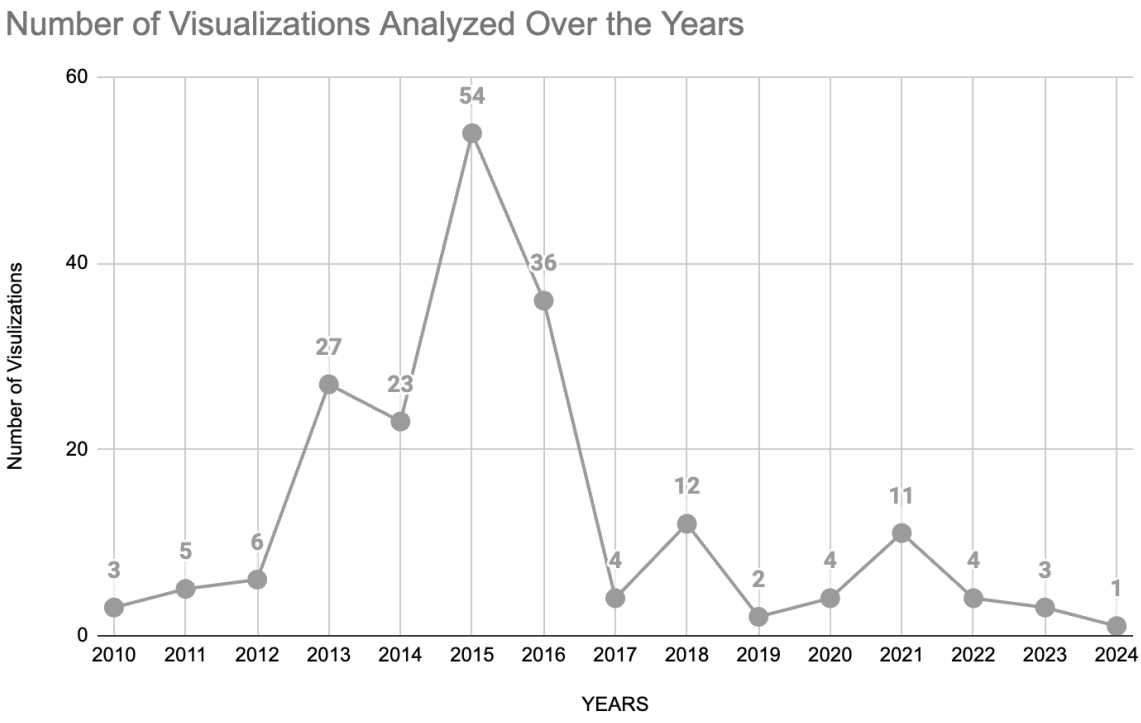
Source: Own elaboration, 2024.

Animation is the most frequently used element in isolation, appearing as the sole juicy element in 94 visualizations. In contrast, only one visualization featured audio feedback as the sole juicy element. When two or more juicy elements were combined, animation was always present. This is particularly true for the particle element, which logically appears alongside animation, as particles are typically animated.

In terms of the timeline, we analyzed interactive visualizations created between 2010 and 2024. Figure 4 displays the distribution of occurrences over the years:

Figure 4.

Interactive Visualizations Analyzed Over the Years.

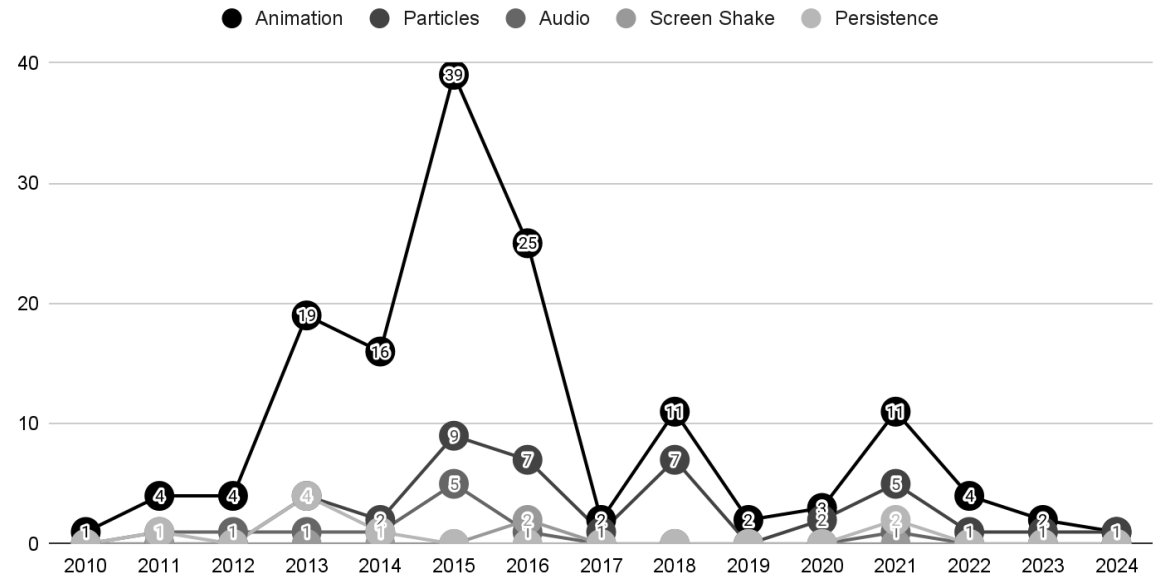


Source: Own elaboration, 2024.

It was then investigated the occurrence of Juicy Elements over the years. Figure 5 shows how many times they appeared on interactive visualizations for each year.

Figure 5.

Interactive Visualizations Analyzed Over the Years.



Source: Own elaboration, 2024.

The animation trend shown in Figure 5 mirrors the overall pattern of interactive visualizations per year as displayed in Figure 2. This confirms that animation is the most widely explored juicy element in the analyzed visualizations. Both figures show a notable increase in the use of animations, particles, and audio between 2014 and 2016. One possible explanation for this growth is that by this time, support for CSS animations —introduced in 2009 with CSS3— had become well-established across major browsers. As a result, visual designers and programmers were likely actively exploring the potential of these new animation capabilities.

6. DISCUSSION

The findings from the analysis reveal that juicy elements are present in a significant number of interactive visualizations, but none of the visualizations analyzed incorporated all five juicy elements simultaneously. This suggests that while individual elements, such as animation and particles, are frequently used, achieving a comprehensive experience that includes all juicy elements remains uncommon. Notably, two visualizations —Optikammer by Team Optikammer (2016) and Seeing CO2 by Extraordinary Facility (2021)— were identified as incorporating four juicy elements. Optikammer lacked the element of persistence, while Seeing CO2 did not feature screen shake. Both visualizations provide real-time controls, allowing users to interact with the content using keyboard inputs, further enhancing the immersive nature of these examples. These real-time interactions, which are akin to a gameplay experience, suggest that they are particularly successful examples of integrating juiciness within interactive infographics.

However, it is important to note that despite the presence of some juicy elements, no single visualization captured the full essence of juicy design, which ideally offers a high level of feedback from minimal user input. This raises an important question regarding the effectiveness of juiciness in interactive infographics: Is it necessary to include all juicy elements for a visualization to be considered "juicy," or can the integration of a few carefully selected elements still significantly enhance user experience? The analysis indicates that the success of juiciness may be less dependent on the quantity of elements and more on their thoughtful integration within the design. According to Pichlmair and Johansen (2021, p. 147), "Juiciness requires exact timing of particle emissions, freeze frames, audio cues, perspective changes, and potentially many more parts of the game." The way these elements are executed and aligned with the visualization's goals plays a crucial role in shaping the overall user experience.

Furthermore, the study revealed that a substantial portion of interactive infographics included at least one juicy element, with animation emerging as the most prevalent. This finding is consistent with the growing trend of using animations in digital design, where the incorporation of motion serves to capture attention and guide users through content. While animation alone can make an infographic engaging, combining it with other juicy elements like particles, audio feedback, and persistence could amplify the interactive experience, creating a more dynamic and compelling interaction.

Interestingly, the analysis of combinations of juicy elements also highlights certain patterns. For example, animation was always present when other elements, such as particles, audio feedback, or persistence, were included. This suggests that animation is a central component in interactive infographics, often serving as the foundation upon which other elements are added. The frequent pairing of animation and particles is particularly notable, as particles are often animated to enhance the visual experience. This combination exemplifies the potential of using juiciness to create a more immersive and visually appealing interaction with data.

Another key insight from the study is the trend over time. The distribution of interactive visualizations analyzed across the years (2010-2024) reveals a steady increase in the use of animation, particles, and audio feedback starting around 2014. This coincides with the widespread adoption of CSS3, which enabled more sophisticated animations across web browsers. The increased support for these technologies likely encouraged designers to experiment with and explore new possibilities for animated interactions, leading to the greater integration of juicy elements. As interactive design continues to evolve, it is expected that the use of such elements will expand, offering even richer and more engaging user experiences.

Moreover, the focus of this study on freely accessible interactive infographics presents a limitation, as it excludes high-quality, paid infographics often found in premium publications or funded research projects. These paid infographics may incorporate more advanced technologies, providing greater opportunities for incorporating a wider range of juicy elements. Investigating interactive infographics from subscription-based platforms, such as major newspapers and journals, could provide further insights into how juiciness is utilized in these more resource-rich contexts. Such a study could also reveal whether paid visualizations make more extensive use of juicy elements,

reflecting the increased resources available for their development.

6.1. Limitations and suggestions for future research

The variability in the level of interactivity within the visualizations examined also raises important questions about how we define and measure interactivity in this context. Some of the visualizations analyzed were labeled "interactive" based solely on the inclusion of basic scroll functionality, while others offered more complex interactions, including real-time data manipulation and multimedia content. This disparity in the degree of interactivity underscores the need for a more precise framework to assess interactive infographics. Future research could investigate whether simple interactions like scrolling are sufficient for labeling a visualization as "interactive," or if a higher threshold is necessary to classify it as truly engaging. Additionally, as seen in the variety of interactivity types across different visualizations, it would be valuable to explore how users perceive and interact with these features in different contexts, and whether the degree of interactivity influences their perception of juiciness.

Identifying specific sources that list interactive visualizations (such as infographics and data visualizations) proved challenging, suggesting an opportunity to gather and consolidate these interactive approaches within a single repository. Additionally, while many visualizations are labeled as interactive, the degree of interactivity varies significantly. For instance, some visualizations are considered interactive merely due to scroll functionality without any clickable elements, whereas designs become more engaging when incorporating "scrollytelling" techniques, which blend scrolling with multimedia content (Seyser & Zeiller, 2018). Other visualizations provide a more dynamic experience, akin to a mini-game, where real-time, direct input controls influence navigation.

This variability underscores the need for a closer examination of the minimum criteria required to classify a visualization as interactive: Should scrolling alone suffice? Is there an upper boundary for interactivity? Further research could aim to assess user perceptions of juiciness in interactive visualizations by inviting participants to engage with them and offer feedback on their juiciness experience.

The focus of this research on freely accessible online infographics limited access to those funded through paid initiatives or projects. Projects with dedicated funding may have greater resources and development time to employ advanced technologies, which could support the inclusion of more juicy elements. Future studies could gain valuable insights by investigating interactive infographics available through paid subscriptions offered by major news outlets such as The New York Times, The Washington Post, The Guardian, and similar publications.

A language constraint was also encountered, with most analyzed visualizations being in English, alongside some examples in Spanish, French, German, Portuguese, and Russian. Future studies may find it beneficial to analyze infographics in other languages, including Japanese, Cantonese, Mandarin, Arabic, and others, to determine whether language-specific visualizations yield differing results.

7. CONCLUSIONS

This study aimed to explore the application of juicy elements within interactive infographics and data visualizations, specifically focusing on how these elements contribute to user engagement and overall interaction experience. By analyzing 195 interactive visualizations, the research confirmed that juicy elements, such as animation, particles, audio feedback, persistence, and screen shake, are widely used, with animation appearing most frequently. These elements were found to enhance user engagement, aligning with the broader concept of juiciness in design, which seeks to add an emotional layer of interaction to the user experience.

The analysis revealed that the integration of juicy elements varies significantly across visualizations. While no single visualization incorporated all five juicy elements, combinations of up to four were observed, suggesting that juiciness does not require a uniform or exhaustive application of all elements. Instead, the strategic integration of a few well-designed elements can create a highly engaging experience for users. This aligns with the idea that juiciness, much like other design principles, is about the thoughtful application of elements rather than their mere presence.

Furthermore, the study highlighted that animation is by far the most prominent juicy element, both in isolation and in combination with others, particularly particles. This suggests that animation has become a key tool for enhancing interactivity in modern data visualizations, perhaps driven by advances in web technologies like CSS3 and JavaScript. These trends emphasize how the evolving technical capabilities of the web influence the ways in which designers apply juiciness in their work.

The research also raised important questions about the definition of interactivity in visualizations. The variety of interactive features —ranging from simple scrolling to real-time user input— illustrates the fluidity of what can be considered interactive. This underscores the need for further exploration into the criteria that define an "interactive" infographic and how different levels of interactivity might impact user perception and engagement. Additionally, the study focused on freely accessible online infographics, which, while useful, may not represent the full range of possibilities in interactive design. Paid sources with more resources could potentially offer more complex and richly designed examples that may further develop the concept of juiciness.

This study contributes to the growing body of work on the intersection of interactive design and user engagement, emphasizing that juiciness is a valuable tool in creating more engaging and emotionally resonant visualizations. However, it also demonstrates that juiciness is not the only factor influencing the effectiveness of an interactive experience. Instead, it is one component of a larger design strategy aimed at fostering engagement, enhancing comprehension, and improving the overall user experience. Future studies could explore how juiciness can be integrated with other key design principles, such as accessibility, clarity, and usability, to create more effective and inclusive interactive infographics. Additionally, further research could investigate the impact of juiciness on user behavior, learning outcomes, and information retention, providing deeper insights into its practical applications in fields such as education,

journalism, and data analysis.

In conclusion, this study provides a detailed examination of the role of juicy elements in interactive infographics and data visualizations. It not only contributes valuable insights into current design practices but also sets the stage for further research into the broader implications of juiciness in digital design. As the field of interactive design continues to evolve, the potential for juiciness to enhance user engagement and learning will undoubtedly remain a critical area of exploration.

8. REFERENCES

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